Letter from Alexander Graham Bell to Marian Bell Fairchild, October 16, 1906

Beinn Bhreagh, near Badddeck, Nova Scotia. October 16, 1906 Mrs. David G. Fairchild, 1331 Connecticut Avenue, Washington, D. C. My dear Daidums:—

Now that the baby is no longer a ? novelty, perhaps you maybe interested in knowing something of the progress of my baby the “Ugly Duckling”.

My baby was gaine d considerably in weight, and her power of locomotion has increased very percept i bly. She now exerts a force equivalent to 15 horse power, as we have replaced the little gasolene motor by a gasolene engine weighing more than 650 pounds, and having four cylinders instead of one. We have not , however , very greatly increased our speed of propulsion, for the floats are not adapted to speed and the increased weight of the machine causes them to sink more deeply into the water — which is also disadvantageous.

I send you a copy of a laboratory dictation entitled, “Significance of Certain Results Obtained with the Ugly Duckling” and “Application to Marine Propulsion”.

I am sure that both you and David are interested in my work here, and would like to hear from me upon the subject from time to time. You should remember however that these communications are confidential at the present time, and should not be 2 repeated to Tom, Dick, and Harry. They contain germs of thought that may perhaps be developed here into something useful; but they are inf ectio us germs liable to grow anywhere in good soil, and I should hate to have a development elsewhere before having a chance to cultivate them myself in my own Laboratory — more especially if the scattered seeds were sown prematurely by my own hand. Therefore consider all Laboratory dictations as confidential for the present.

That was a dear little lock of hair you sent me and I am having it placed in a picture frame for preservation. It will be hung up in my study to remind me of my little grandson. We have had no report recently of bab ie y 's weight, I hope sincerely that he is now making up for lost time and improving rapidly. He should certainly do so when he has a cow as well as a mother to support him.

My baby has developed much faster than yours; for already she has become a mother herself. Another little “Ugly Duckling” is nearly hatched. You remember the “Edbert”, the twin boat I constructed some years ago, which was towed backwards and forwards across the Bay by a kite. We are now fitting her out again with the little one-cylinder gasolene motor that was form al er ly used upon the “Ugly Duckling” (mere). I think the “Edbert” will probably be driven at a higher speed by the little motor than the “Ugly Duckling” by the big motor. The “Edbert” is comparatively light, more adapted for speed than the other, and we propose in addition to give her the advantage of hydroplanes submerged beneath her bottom levels .

Your Loving Father Alexander Graham Bell

1906 October 16 Tuesday At Beinn Bhreagh.

SIGNIFICANCE OF CERTAIN RESULTS OBTAINED WITH THE UGLY DUCKLING.

(Dictated by A. G. B. to M. G. B., typewritten by C. R. Cox.)

I am much struck by the significance of the fact that the Ugly Duckling, which can only make a speed of about four miles an hour in a calm, is yet able to make headway against a wind that raises small white cpas caps on the Bay (estimated at from 14 to 20 miles an hour).

Whatever the exact velocity of the wind, it certainly exceeds very greatly the maximum velocity possible to the Ugly Duckling under present circumstances; and yet she is able to make headway against that wind.

The Steamer Blue Hill has a speed of about 12 miles an hour and she thinks nothing of facing a 25 mile wind — but her propellers act in the water instead of the air. If she were moving against a current of water the case would be very different. She could not possibly face a 25 mile current of water unless her engines had power enough to propel her at a greater rate than 25 miles an hour in calm water. Under present circumstances she would drift backwards at the rate of 13 miles an hour (25 -12) with her engines in full swing.

2

The propellers of the Ugly Duckling act exclusively upon the air. She derives no assistance whatever from the water Indeed, she must overcome the resistance of the water as well as the air before she can move at all against the wind. The water retards and does not assist. With a maximum possibility (at present) of 4 miles an hour, the Ugly Duckling makes headway against — say — a 10 mile breeze; and in addition overcomes considerable resistance from the water. It raises great waves on the water, as its floats are not built for speed; and its power of propulsion is derived exclusively from the air.

To me this is very significant; and indicates that a flying-machine of the heavier-than-air type — unlike the balloon — will be able to make headway against a breeze that blows backwards at a greater rate than the machine propels forward — a paradoxical statement. The greater the specific weight of the machine, the less influence should the wind have in retarding its motion. A very heavy machine propelled at 25 miles an hour might make headway against a 50 mile wind.

A specifically light body, like a balloon, if released in the air will drift with the wind acquiring substantially the velocity of the wind; and it cannot make headway against the wind unless

provided with engines capable of propelling it, in a calm, at a greater velocity than the wind.

But now consider the case of a specifically heavy body, like a Kite flying in a good wind. Cut the cord and let it free. It falls slowly under gravity; and drifts with the wind; but, unlike the balloon it does not drift backwards with the velocity 3 of the wind. If you simultaneously release a number of similar Kites provided with different loads, the lighter kites will drift furthe st r and acquire a greater horizontal velocity than the heavier under the action of the wind. Imagine a specific case :— A heavy kite, under the influence of a 10 mile breeze, may drift — say — at the rate of 4 miles an hour. If then the kite should be provided with an engine and propellers capable of producing an onward velocity exceeding 4 miles an hour, should it not be able to face the 10 mile breeze and make headway against it? The behavior of the Ugly Duckling is strongly suggestive of the truth of this important proposition.

APPLICATION TO MARINE PROPULSION.

It is very difficult to dissociate in the mind absolute weight , from relative or specific weight. We are apt to look upon a steamship as a very heavy object, and so it is, absolutely; but relatively to the medium which supports it, it is very light. It is even lighter, relative ly to the water, than a balloon is relatively to the air. The balloon has simply the same specific weight as the medium stratum of air in which it floats; but the steamship is lighter than its own bulk of water. It does not simply float, like a water-loged vessel, in the water, but on nit. It rises to the surface and beyond above , for only a portion of it is submerged. Hence the steamship is more at the mercy of the water than the balloon is at the mercy of the air; and can only make headway by the expenditure of excessive energy.

4

Steam-power is as disadvantageously employed in the propulsion of steam-vessels specifically lighter than the water through which they move , as it is in propelling balloons

through the air. This is well illustrated by the fact, that, in marine propulsion it takes an enormous increase of power to effect a very slight increase of velocity. We place hundreds of horse power in a little cockleshell of a torpedo boat, and after all obtain a velocity quite incommensurate with the power expended. Does this not result from the fact that we are urging our torpedo boat against a medium of greater specific weight than itself? If a torpedo boat could be made so heavy relatively to the water, that it would sink to the bottom like a mass of lead if not propelled, would not its power be productive of greater velocity than if it were specifically lighter than the water? It is obvious that it would take less power to propel a pound of lead through the air at a given velocity, than a pound of feathers. Why should not the same thing be true in water?

It would certainly take less power to propel through the water at a given velocity a body that will sink in still water , than a body of similar weight that will float. In such a case of course it must be kept up by its own velocity, and not by any inherent buoyancy. It should be therefore be provided with the water equivalent of wings — hydroplanes instead of aeroplanes. These, set at a suitable angle, would support the body when propelled, as aeroplanes support a flying-machine, or wings a bird.

5

In Aerial Locomotion we have heavier-than-air machines and lighter-than-air. Why should we not have heavier-than-water machines, as well as lighter-than-water?

The French invention of a hydroplane to assist marine propulsion seems to me to be one of the most important of modern times, for it means no less than a revolution in ship-building comparable to the change that will take place when dirigible balloons give way to flying-machines.

A steamship weighs exactly as much as the water it displaces, Now submerged hydroplanes set at a suitable angle tend to lift the vessel out of the water the moment she gets headway. The advantages are two-fold:—

1. The portion of the hull that emerges from the water meets only with air resistance instead of water resistance s and is therefore less retarded.

2. The portion of the hull that remains in the water displaces a less amount of water than before; so that the vessel as a whole weighs more than the water displaced, and has therefore all the advantage of momentum that would be possessed by a body specifically heavier than the water.

Floating vessels provided with hydroplanes need fear no leaks so long as their propelling-machinery is uninjured, for they no longer depend upon buoyancy for support. The hydroplanes will support them so long as they can keep in motion.

The advantage of great specific weight would specifically be felt by sub-marine vessels that are wholly submerged during the process of propulsion.

6

Consider the case of two sub-marine vessels of equal displacement but different weights. The heavier vessel should be able to attain a higher velocity than the lighter. Or take two submarine vessels of equal weight and different displacements. The one that has the least displacement will be driven faster by the same engine power than the other.

The attempt to produce heavier-than-air flying-machines in place of dirigible balloons will have a profound influence upon marine-propulsion. Our present shipping are in the balloon stage; and our steamships correspond to dirigible balloons driven by their own power. The day is coming when we shall have heavier-than-water steam vessels which will correspond to flying-machines; and the aeroplane, converted into a hydroplane will effect s a revolution in marine navigation.

(For rough draft of dictation see home notes for 1906, October 16, pp 188–193).

AGB